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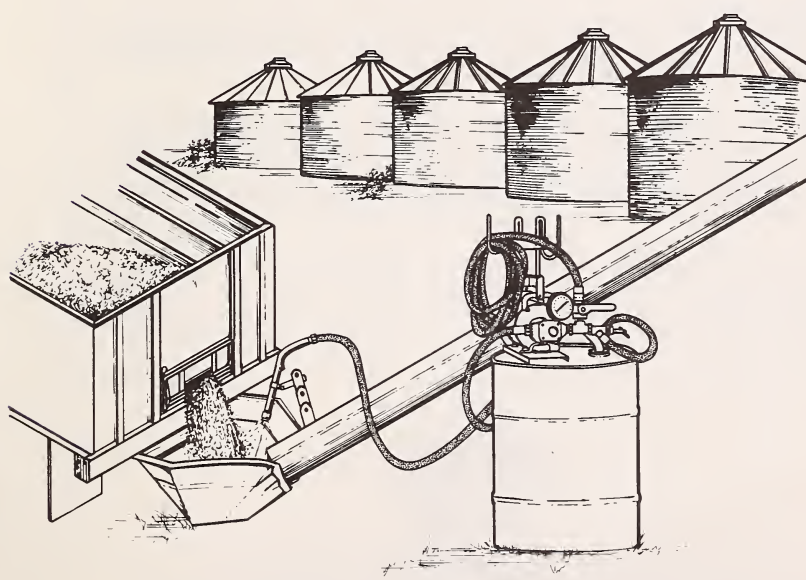
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# Grain Protectants for Insect Control

## Methods and Equipment for Bulk Treatment

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## Precautions

To protect people, pets, livestock, wild life, and the environment from harm, the use of pesticides is regulated under the Federal Insecticides, Fungicides, and Rodenticides Act (FIFRA), as amended by the Federal Environmental Pest Control Act of 1972, and the Federal Food, Drug, and Cosmetic Act of 1938 as amended. The rate and method of application and any resulting residues must comply with the requirements of these acts. Products in violation of the Food, Drug, and Cosmetic Act are subject to Federal action. The instructions given in this publication are intended to assist the user in complying with these regulations.

The established tolerances in parts per million (ppm) for insecticides recommended in this publication are as follows:

Insecticide	Grain	Tolerances (ppm)
Pyrethrins.....	Oats .....	1
	Sorghum .....	1
	Other grains .....	3
Piperonyl butoxide .....	Oats .....	8
	Sorghum .....	8
	Other grains .....	20
Malathion .....	All grains .....	8
	(but not such oilseeds as soybeans and sunflowers)	

## Use Carefully

Insecticides are poisonous. They should be used only when needed, and they should be handled with extreme care. Follow directions and precautions on container labels carefully.

When you handle or mix any insecticide concentrate, avoid spilling it on the skin and keep it out of your eyes, nose, and mouth. If you spill any on your skin, wash it off immediately and change your clothing. If you splash insecticide in your eyes, flush them with plenty of water for about 15 minutes and then get medical attention.

The insecticides mentioned in this publication have not been designated as restricted under FIFRA. Pyrethrins, piperonyl butoxide, and malathion can be applied safely without special protective clothing or devices, provided they are in dilute dusts or water sprays.



*Use Pesticides Safely*  
FOLLOW THE LABEL  
U.S. DEPARTMENT OF AGRICULTURE

## **Abstract**

Quinlan, J. K. 1982. Grain Protectants for Insect Control: Methods and Equipment for Bulk Treatment. U.S. Department of Agriculture Marketing Bulletin Number 72. 12 p.

New and old technology has been developed during the past 30 years for applying grain protectants. A grain protectant is defined as treatment applied throughout the mass of bulk grain as it goes into storage bins to prevent insect infestation during the storage period.

Protectants are applied as emulsions and as dusts. Malathion and synergized pyrethrins are the only registered insecticides. The equipment used are common garden-type sprayers, pressurized closed-system sprayers, power-pump sprayers, metering-power sprayers, "drip on" application, and dust applicators.

The main factors that influence effectiveness of protectants are application pressure, moisture, and grain temperature. Grain should not be treated at temperatures over 90° F and at moisture contents over 13 percent.

**KEYWORDS:** grain protectant, malathion, synergized pyrethrins, sprayers, "drip on" application, dust applicator.

## **Acknowledgments**

I wish to acknowledge the development (design and testing) of the spray application systems (figs. 6 and 7) by William B. Gehl and (fig. 8) by Kenneth D. Bunkowski, American Cyanamid Co., Agricultural Division, Princeton, N.J.; the development of the metering equipment found in figure 8 and designated as pictures 10a and 10b by Jim Cook, J. Chem., Houston, Tex.; and the drawings of the application equipment by Jeanne E. Cardana, U.S. Grain Marketing Research Laboratory, Manhattan, Kans.

## Contents

Protectants and tolerances .....	1
Factors that influence effectiveness of grain protectants .	1
Insecticide formulations .....	5
Equipment required .....	7
Installation .....	7
Method of calibration .....	8

Trade names and the names of commercial companies are used in this publication solely to provide specific information. Mention of a trade name or manufacturer does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

# Grain Protectants for Insect Control

## Methods and Equipment for Bulk Treatment

James K. Quinlan<sup>1</sup>

### Protectants and Tolerances

Research and practice during the last 30 years have shown that grain can be protected against insect infestation by applying a protective treatment at the time of storage. A grain protectant is defined as a treatment applied throughout the mass of bulk grain as it goes into storage bins to prevent insect infestation during the storage period. Not included in this definition are bin wall treatments or treatments applied to the upper surface or layer of the grain, which also add protection against insect infestation.

Insecticides approved for use as protectants on grain are malathion and synergized pyrethrins. A toler-

ance of 8 ppm has been established for malathion by the Food and Drug Administration. The pyrethrins are usually synergized with piperonyl butoxide at a ratio of 1 part of pyrethrins to 10 parts of piperonyl butoxide. The tolerances for these are 3 ppm of pyrethrins and 20 ppm of piperonyl butoxide for most grains and 1 ppm of pyrethrins and 8 ppm of piperonyl butoxide for oats and grain sorghum.

### Factors That Influence Effectiveness Of Grain Protectants

**Proper mixing**—Even application is important, and one disadvantage in using the emulsifiable formulations is that most of them must be agitated about once every half hour after mixing with water to avoid settling. The gravity flow or “drip on” applications (figs. 1 and 2), the garden-type sprayers (figs. 3 and 4), and the pressurized spray tank (fig. 5) must be shaken to insure that the formulation is applied evenly. The power sprayers (figs. 6 and 7) do not have to be shaken as the formulation agitates continuously. The

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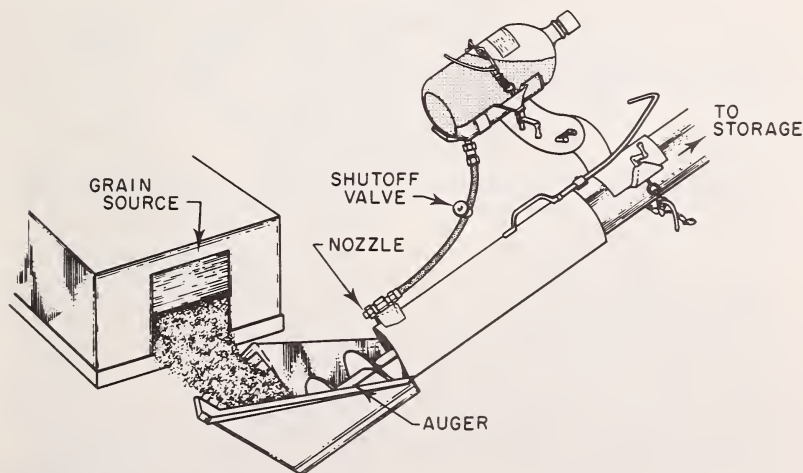
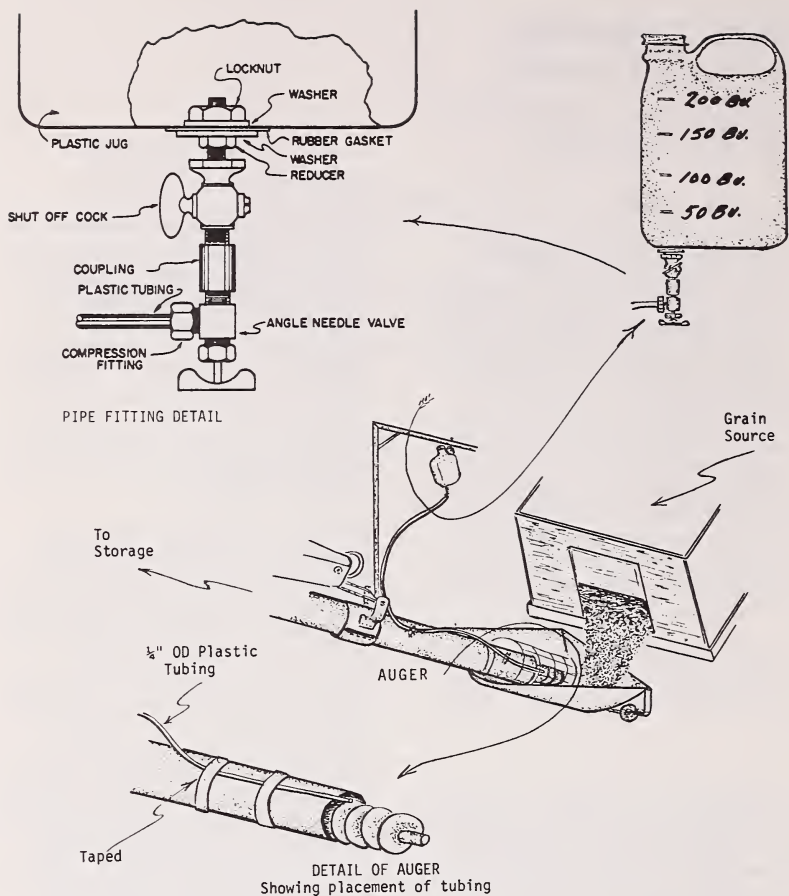


FIGURE 1.—Gravity feed or “drip on” applicator.





#### PROTECTANT "DRIP ON" ASSEMBLY

FIGURE 2.—Schematic drawing of a gravity feed "drip on" system used to apply grain protectants (Quinlan 1980).

metering sprayer (fig. 8) feeds the concentrate into a continuous stream of water.

**Fresh formulations**—Mix enough insecticide with cool water for one day's use only; do not carry over for the next day's treatment. Keep concentrate, mixed spray, and dust cool and do not store in direct sunlight. Use fresh dust formulations and avoid carryover from one year to the next. If the dust must be kept over, it should be refrigerated.

**Application point**—Apply insecticide treatments evenly and as close to the point of final storage as practical. Protectants can be applied into an auger (fig. 4A) or into the grain stream as the grain falls into the auger hopper (fig. 3). Protectant also may be applied as grain falls into the bin. Grain that is treated and then transferred long distances through such numerous grain-handling systems as pneumatic systems, belt augers, conveyors, spouts, and legs before storage will





BN 49328

FIGURE 3.—Compression-type garden sprayer with nozzle mounted on auger. Nozzle is directed to grain in the auger hopper.

have less residues when the grain is finally dropped into the bin. Insecticide left in the handling system, however, will help reduce insects in these areas.

**Application pressure**—Keep the spray pressure as low as possible: 10 to 20 pounds per square inch (lb/in<sup>2</sup>) is preferred. The lower the pressure, the larger the spray droplets. The larger droplets fall onto the grain and are less likely to drift off into the air.

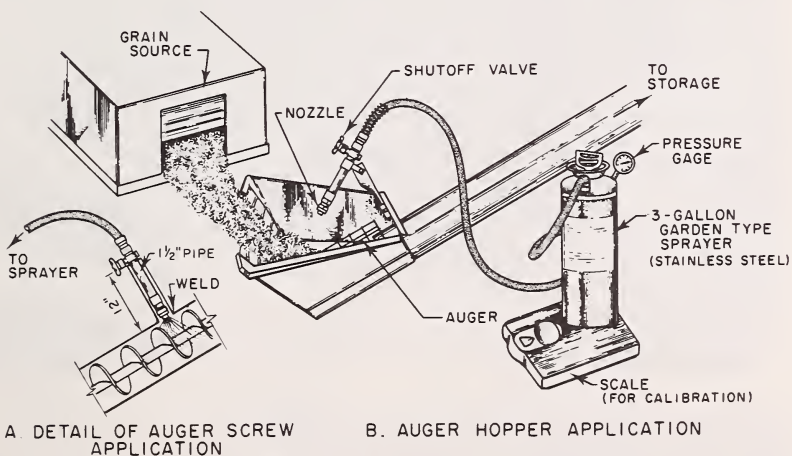


FIGURE 4.—A. Installation of nozzle assembly directed into auger screw. B. Installation diagram for a compression-type garden sprayer with nozzle mounted on auger. Nozzle directed to grain in the auger hopper.

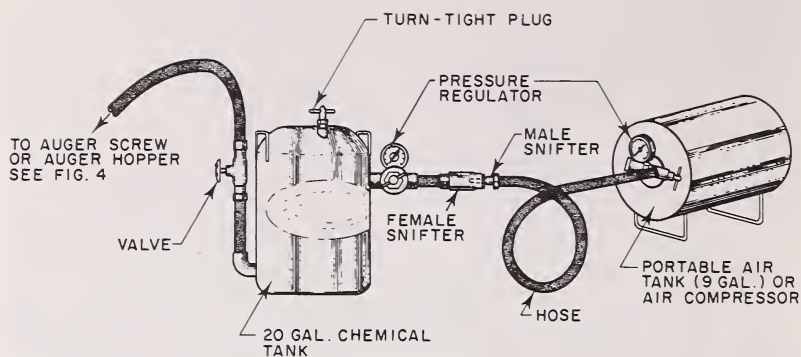
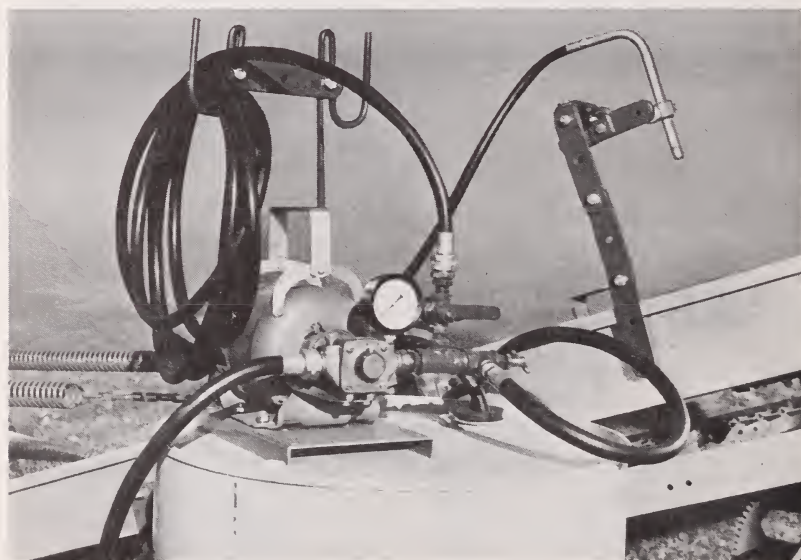


FIGURE 5.—Pressurized spray tank.

### Grain Moisture and temperature

—Most failures with malathion occur because of excessive grain moisture or temperatures or both. Grain should not be treated if it is above 13 percent moisture and the temperature is above 32° C (90° F). If

warm grain above 32° C is treated, it should be cooled with an aeration system as soon as it is practical. Operating an aeration system will not remove the protectant from the grain. Table 1 shows the rapidity at which malathion will degrade at



BN 49327

FIGURE 6.—Power sprayer that consists of a nylon gear or roller pump, equipped with Vitron or leather seals (leather and Vitron are not affected by the action of the insecticide), ¼- to ½-horsepower 110-volt motor, 8-foot suction hose with removable suction strainer, 7-foot bypass hose, ½-inch pressure regulator, pressure gage, shutoff valve, 20-foot pressure hose, spray nozzle, and nozzle bracket.

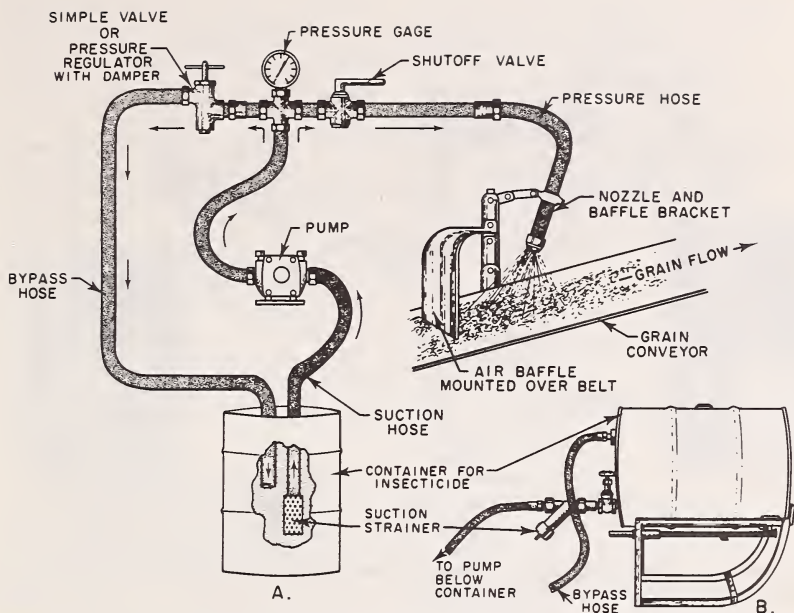


FIGURE 7.—A. Installation diagram for grain protectant sprayer. B. Horizontally placed insecticide container.

26.6°C (80°F) and at four moisture contents. As a 2.0 ppm residue will prevent the development of most stored grain insects (except the Indianmeal moth, *Plodia interpunctella* (Hübner)), a grain treated at 14 percent moisture will be effective up to 6 weeks.

### Insecticide Formulations

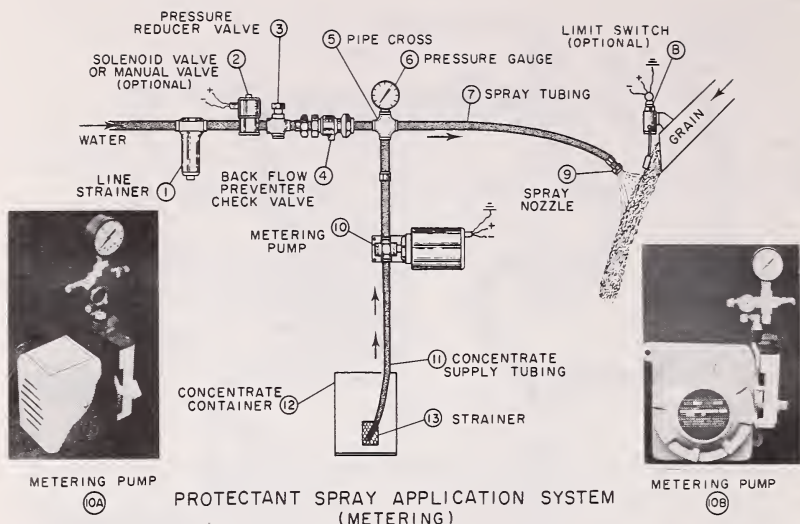
**Emulsifiable Concentrate—**For the protection of such stored grains as wheat, oats, rough rice, corn, rye, barley, and grain sorghum, 1 pt (16 oz) of 57 percent premium-grade malathion emulsifiable liquid concentrate or 10 oz of 83.7 percent malathion emulsifiable concentrate mixed in 2 to 5 gal of water should be applied to each 1,000 bu of grain. Two pt (32 oz) of emulsifiable concentrate containing 6 percent of pyrethrins and 60 percent piperonyl butoxide mixed in 7 gal of water should be applied at the rate of 5 gal to each 1,000 bu of grain. Adding 5 gal of water to 1,000 bu of grain will increase the moisture content of the grain to less than 0.1 of 1 percent.

TABLE 1.—Malathion residues (ppm) on wheat at 4 moisture levels following application rate of 7.5 ppm<sup>1,2</sup>

Interval after treatment	Malathion residues at indicated moisture content			
	10%	12%	14%	16%
	..... ppm .....			
24 hours	6.2	6.1	5.7	5.0
6 weeks	6.4	4.9	2.0	0.4
3 months	4.6	4.2	1.1	0.2
6 months	2.8	2.6	0.3	0.1
9 months	2.7	2.5	0.3	<0.1

<sup>1</sup> Wheat was stored in sealed jars at 26.6°C (80°F). Temperatures of grain held below 26.6° will result in higher residues and temperatures above 26.6° in lower residues.

<sup>2</sup> Quinlan, J. K., J. L. Wilson, and L. I. Davidson. 1980. Pirimiphos-methyl as a protectant for high moisture stored wheat. *Journal of the Kansas Entomological Society* 53:825-832.



PROTECTANT SPRAY APPLICATION SYSTEM  
(METERING)

FIGURE 8.—Spray application system for metering protectant to grain conveyed to storage.

BN 49326

#### Item and description

- ① Line strainer with 30- to 50-mesh screen.
- ② Solenoid valve— $\frac{1}{4}$  in to  $\frac{1}{2}$  in, 2-way, 110-volt a.c. or 12-volt d.c. as required.
- ③ Pressure reducer valve— $\frac{1}{2}$ " National Pipe Thread (NPT), 0 to 60 lbf/in<sup>2</sup> control range.
- ④ Back flow preventer check valve— $\frac{1}{4}$  in to  $\frac{1}{2}$  in.
- ⑤ Pipe cross— $\frac{1}{4}$  in standard NPT, aluminum, brass, or stainless steel.
- ⑥ Pressure gage—4 in dial, 0 to 60 lbf/in<sup>2</sup> range.
- ⑦ Spray tubing— $\frac{1}{4}$  in to  $\frac{1}{2}$  in outside diameter, length to suit.
- ⑧ Limit switch—interlocked with items 2 and 10, to actuate or terminate spray unit at start and stop of grain flow.
- ⑨ Spray nozzle—size determined by flow rate of grain and liquid.
- ⑩ Metering pump assembly—select meter to suit grain capacity flow rate and electrical requirements. 10A. Example of low-flow metering pump. 10B. Example of high-flow metering pump.
- ⑪ Supply tubing— $\frac{1}{4}$  in to  $\frac{1}{2}$  in inside diameter tubing.
- ⑫ Protectant feed container as received from supplier—5- to 30-gal or 55-gal sizes.
- ⑬ Line strainer—50 mesh.

Note: Limit switch (item 8) is optional, as well as item 2, solenoid valve.

Solenoid valve (item 2) may be alternate manual valve for starting and stopping flow-through system. Items 2 and 8 are conveniences that provide unattended control to the system.



**Wheat flour dust.**—Wheat flour dust formulations are 1 percent malathion at 60 lb, 2 percent at 30 lb, and 6 percent at 10 lb per 1,000 bu of grain.

### Equipment Required

**Emulsifiable concentrate.**—Any low-pressure sprayer that can be calibrated to deliver a known volume of liquid is suitable for applying liquid protectants. This includes compression sprayers (figs. 3, 4, 5) and electric- and gasoline-engine-driven power sprayers (figs. 6, 7, 8). The garden-type compression sprayer and the gravity feed “drip on” system are used to treat small lots of grain.

Power sprayers and metering-type sprayers are generally used to treat large lots of grain. In some areas, insurance terms require totally enclosed fan-cooled motors in grain elevators.

The correct size of orifice in the sprayer nozzle is important because orifice size and pressure are used to regulate the rate of insecticide flow. Most manufacturers of spray nozzles have charts that give the capacity in gallons per minute and the spray angle for each size of orifice.

A simple gravity or “drip on” applicator that does not use any moving parts may be purchased (fig. 1) or constructed (fig. 2). An applicator may be built by fitting two brass valves and polyethylene tubing in sequence to an opening in the bottom of a plastic container. These fittings are obtainable at plumbing supply shops. The upper shutoff cock on the jug (see “Pipe Fitting Detail” fig. 2) serves as the on-off valve while the lower needle valve regulates the amount of insecticide flowing through the plastic tubing. The needle valve is first calibrated to the desired flow for the rate-of-grain delivery into storage. It then can be kept at the same setting without the need for fine adjusting each time flow is turned on.

The gravity feed applicator is used as grain is unloaded from a truck or

auger into the hopper of a portable auger. The tubing is taped horizontally along the auger tube at the pick-up end, with the end of the tubing extending one-fourth inch beyond the end of the auger tube so the insecticide flows directly into the grain. The plastic container can be suspended from the top of the grain bin or auger and must be agitated by hand at periodic intervals.

The following supplies are needed to build the gravity feed “drip on” applicator:

- 1 plastic container  
128 to 384 oz
- 1 lock nut  
1/4 in 18 pipe thread (PT)
- 2 washers  
1/2 in
- 1 rubber gasket  
1/4 in
- 1 pipe reducer  
1/4 in 18 PT x 1/8 in 27 PT
- 1 shut-off cock  
1/8 in 27 PT x 1/8 in 27 PT
- 1 pipe coupling  
1/8 in 27 PT x 1/8 in 27 PT
- 1 angle needle valve  
1/8 in 27 PT x 1/4 in OD
- Polyethylene tubing  
8 ft x 1/4 in outside diameter

**Wheat flour dust formulations.**—For small lots of grain, special dust applicators may be used (fig. 9). Different models are made by various manufacturing companies that use the 1- or 2-percent formulations. These dust formulations are sometimes applied before binning by spreading them evenly over the grain surface while the grain is in the truck. The formulation is then mixed in with a shovel and is mixed further as the grain falls into the auger hopper.

In grain elevators, a larger applicator is available that uses a 6-percent formulation.

### Installation

To obtain the proper application rate or to get complete coverage on a wide belt, it is necessary to use two or more nozzles.

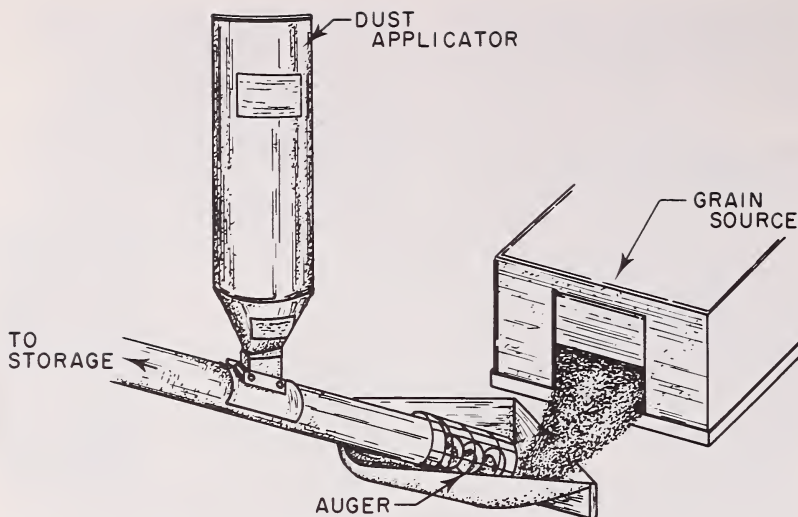


Figure 9.—Installation diagram of an auger-type dust applicator. Applicator is powered by the screw inside auger.

When you spray grain on a moving belt, keep the nozzle 6 to 8 in above the belt and angle the spray against the flow of grain (fig. 7A). Set the nozzle so that the spray pattern covers the entire width of the stream of grain but does not touch the belt. Air movement above the belt around the spray nozzle should be eliminated to keep the spray from drifting off into the air instead of onto the grain. This can be done by placing a baffle across the belt several inches above the grain. This baffle deflects the air and allows the spray to fall directly on the grain.

### Method Of Calibration

After the turning rate of the grain passing on the belt, auger, or conveyor is known (the amount of grain passing a point in a given time), choose a type of nozzle from the manufacturer's chart that will deliver the gallons per hour needed in the range of 10 to 20 lb/in<sup>2</sup>.

For example, if the turning rate of the grain is 5,000 bu/h, and the amount of insecticide to be applied is 2 gal/1,000 bu, then a nozzle with capacity of 10 gal/h at 15 lb/in<sup>2</sup> is required.

From the manufacturer's chart, choose a nozzle that will deliver 10 gal/h at as low a pressure as possible. Install this nozzle on the sprayer and, using plain water, operate the sprayer at the pressure recommended. Catch all the water delivered in 10 min. Weigh or measure the amount collected and multiply this by six to determine the amount delivered per hour.

The output of the nozzle will vary slightly from the rated output. If the amount collected was more than a gallon, decrease the pressure slightly and rerun the test. If the amount collected was less than a gallon, increase the pressure slightly and rerun the test. Do this until the sprayer delivers the correct amount.

You may calibrate the pressurized garden-type sprayer as above or you may weigh the entire unit with a platform-type scale or with a hanging scale to determine the amount of delivery. One gallon of water weighs about 8.3 lb.